WHC-SA--0954

DE91 001188

Fast Flux Test Facility Interim Examination and Maintenance Cell: Past, Present, and Future

J. R. Vincent

Date Published
September 1990

To Be Presented at
ANS 1990 Winter Meeting
Washington, D.C.
November 11-15, 1990

Prepared for the U.S. Department of Energy
Assistant Secretary for Nuclear Energy

Westinghouse Hanford Company P.O. Box 1970
Richland, Washington 99352

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

MASTER

Approved for Public Release

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

ps

FAST FLUX TEST FACILITY INTERIM EXAMINATION AND MAINTENANCE CELL: PAST, PRESENT, AND FUTURE

J. R. Vincent
Westinghouse Hanford Company
P.O. Box 1970, Mail Stop N2-33
Richland, Washington 99352
(509) 376-4203

ABSTRACT

The Fast Flux Test Facility Interim Examination and Maintenance Cell was designed to perform interim examination and/or disassembly of experimental core components for final analysis elsewhere, as well as maintenance of sodium-wetted or neutron-activated internal reactor parts and plant support hardware. The Interim Examination and Maintenance Cell equipment developed and used for the first ten years of operation has been primarily devoted to the disassembly and examination of core component test assemblies. While no major reactor equipment has required remote repair or maintenance, the Interim Examina Examination and Maintenance Cell has served as the remote repair facility for its own in-cell equipment, and several innovative remote repairs have been accomplished. The Interim Examination and Maintenance Cell's demonstrated versatility has shown its capability to support a challenging future.

I. INTRODUCTION

The Fast Flux Test Facility (FFTF) is a U.S. Government-owned 400-MW (thermal) sodium-cooled fast reactor plant designed for irradiation testing of nuclear reactor fuels and materials, safety research and development (R&D), equipment demonstration for liquid- metal fast reactors, and advanced reactor concept testing. The FFTF is located on the Department of Energy's Hanford Site near Richland, Washington and is operated by the Westinghouse Hanford Company, a wholly owned subsidiary of Westinghouse Electric Corporation.

The Interim Examination and Maintenance (IEM) Cell is located inside the FFTF containment building and is used for disassembly and examination of irradiated fuel and material experiments as well as remote maintenance activities. Some maintenance has been performed on the sodium-wetted grapple of FFTF's fuel assembly and long test assembly refueling machine, the closed loop ex-vessel machine (CLEM), but 90% of IEM Cell availability has been devoted to core component tests. Although some of the types of test assemblies originally planned for processing in the IEM cell have not been irradiated, others not originally planned have been designed, irradiated, and processed. The IEM Cell equipment to support these new tests has been designed and installed as needed. The IEM Cell has served as the remote repair facility for its own in-cell equipment, and several innovative remote repairs that maintained Cell availability have been accomplished.

II. IEM CELL DESCRIPTION

The IEM Cell (Fig. 1) is a 16.8-m (55-ft) high, four-level, L-shaped, shielded hot cell. All in-cell equipment is designed to operate in a dry argon atmosphere and in a high radiation environment (10^4 Gy/h [10^6 rad/h]). It is designed to process 3.7 m and 12.2 m (12 ft and 40 ft) long sodium-wetted reactor assemblies oriented vertically. The inside adjacent sides of the 'L' and the end of the lower leg are equipped with master-slave manipulators (MSM) at lead-glass shield windows. The lower leg of the 'L', the IEM Cell Annex, is served by a wall-mounted bridge-type electro-mechanical manipulator (EMM) (Fig 2) and a bridge crane. The other, larger leg, the Main Cell, is served by a pedestal-mounted EMM (Fig. 3), and a bridge crane (Fig. 4). A ceiling valve provides access to a maintenance turntable (MTT) (Fig. 5) that provides a platform for the transfer or maintenance of reactor or cell equipment. Other cell ports in the ceiling and walls are used for waste container, reactor test assembly, and small tool transfers to and from the IEM Cell. Reactor test assembly processing equipment includes the following:

A. Core Component Receiving Station

The core component receiving station is designed to receive core molten sodium-filled core component pots containing core components for transfer between the CLEM and IEM Cell. The station is attached to the contaminated gas suction manifold, which provides cooling of components by drawing cell atmosphere down around the pots. The station has heaters that, in conjunction with cooling, maintain a predetermined temperature. This station is mounted on an elevator that raises the station to aid CLEM access and lowers it for in-cell crane access.

The station consist of a support base assembly, support frame assembly, receiving container assembly, control console, and a sodium catch pot.

B. Core Component Storage Station

The core component pot storage station provides a place to store core component pots which contain either a driver fuel or test assembly. In addition, the station controls temperature the same way as the Core Component Receiving Station, maintaining the sodium in a molten state. This allows for the removal of core components or for programming the reinsertion of test assemblies after they have been measured.

The core component pot storage station consist of a support frame and two storage locations.

C. Sodium Removal System

The sodium removal system (Fig. 6) is used to remove residual sodium from irradiated core components, surveillance and test assemblies after their removal from the reactor vessel, fuel handling machine grapples, and sodium drip pots.

The sodium removal system receives sodium-wetted items; maintains cooling to remove decay heat, when required; safely reacts and removes the coatings of residual sodium; and drys the component. The system operates with four distinct phases: (1) nonpressurized loading phase, (2) moist gas cleaning phase, (3) water rinse phase, and (4) drying phase.

D. Core Component Measuring Station

The core component measuring station (Fig. 7) is designed to measure specific dimensions: length, bow, twist, dilation, and surface temperature profile of cleaned core components. These measurements are used to determine fuel assembly stability during irradiation and high temperature exposure. The system is connected to the contaminated gas suction manifold to provide temperature control while a component is being measured.

The station is wall mounted with a moveable support structure, and a measuring platform (Fig. 8).

E. Core Component Disassembly/Reassembly Station

The core component disassembly/reassembly station (D/RS) (Fig. 9) is a track-mounted station with a telescoping tower that holds and positions special tools. This unit can be moved between a location in the cell Annex with access from two adjacent window stations, the Annex crane, and the wall-mounted EMM and a location in the main cell beneath the 20-cm (8-in) ceiling port with access to the Main Cell crane and both EMMs. It is designed to hold 3.7-m (12-ft) assemblies and the duct section of 12.2-m (40-ft) assemblies. The telescoping tower can exert 5000 lb of force for duct removal and position various tools for disassembly/reassembly.

F. Fuel Pin Weighing Station

The fuel pin weighing station is used to identifying that fuel pin with a reduced weight due to the escape of gaseous and volatile fission products from a fuel assembly pin bundle. The pin weighing machine is a vibration-isolated electronic balance. A motor-driven arm positions a cradle in front of the machine where a fuel pin is placed, supported by a separately applied collet-type end fitting. The arm is then driven down and the pin is weighed as it hangs directly below the electronic balance. A rugged mounting structure, environmental shields, auxiliary pin handling equipment, and planned short-term cell installation help avoid radiation damage and minimize the abuse of remote manual operation.

G. Peripheral Container and Tool Storage Stations

The IEM Cell is equipped with a variety of tool and storage stations, most of which are attached to the cell liner with a specially designed mounting bracket that allows remote removal or installation as need dictates. Others are mounted to the MTT, which aids in their access.

III. EQUIPMENT ORIGINALLY PLANNED AND DESIGNED BUT NOT INSTALLED OR ACTIVATED.

The following stations were originally planned for installation in the IEM Cell. Some have been built and received initial testing, but to date have not been required or remote-operation perfected. As the need for these stations arises, they will be remotely installed in the cell, tested for proper operation, and placed in service.

- Fuel pin gamma scanning station.
- Fuel pin laser profilometry station.
- Closed loop in-reactor assembly D/RS (used to support CLEM grapple maintenance).
- Fuel pin photo-positioning station.
- In-cell welding equipment.

IV. INSTRUMENTED OPEN TEST ASSEMBLY DISASSEMBLY/REASSEMBLY STATIONS.

The 12.2-m (40-ft) assemblies have two support stations. The Materials Open Test Assembly (MOTA) duct removal installation (DRI) station and the specimen removal/insertion (SRI) station. The DRI and SRI are wall mounted fixtures that support and position the MOTA for duct and specimen installation/removal respectively. The DRI can be positioned under the IEM Cell 20-cm (8-in) ceiling port to receive a MOTA, but when not in use it can be swung to the side allowing room for other components to access the port. The SRI is located to position the MOTA test train near MSMs and a viewing window. The MOTA support on both units is a split, rotating collar mounted in a clamshell clamp. A spur gear operated by an EMM turns the collar. In this way the MOTA can be rotated 360° for access to all sides. The support is mounted on two vertical shafts on linear bearings and can be moved up and down by means of a jack screw. This vertical positioning allows MSMs to reach all operating points. While the DRI has only one support collar, the SRI has two to react the side loads applied during specimen removal.

V. INSTRUMENTED TEST ASSEMBLIES

The FFTF has the capability of on-line instrumentation monitoring of reactor core component assemblies during irradiation. These 12.2-m (40-ft) long assemblies consist of a 3.7-m (12-ft) long in-core section with a 8.5-m (28-ft) long instrument stalk. One Absorber Open Test Assembly (AOTA), a control rod material test, has been processed. The MOTA, containing a set of material test specimens, has become the principle instrumented assembly processed in the IEM Cell. Seven have been completed to date. The MOTAs are brought to the IEM Cell where their outer ducts are removed, exposing the test train for material-specimen removal. The specimens are shipped to the materials laboratory for sorting. Some are selected for testing while the rest along with new specimens are loaded in new specimen holders and returned within ten days to the IEM Cell where they are placed in the test train of new MOTA vehicles. Installation of the outer ducts readies the MOTAs for continued irradiation of a specimen set.

VI. 3.7-METER (12-FOOT) ASSEMBLIES

The original emphasis in processing core assemblies was to characterize the performance of the original reference driver fuel. The IEM Cell now is assigned advanced fuels and materials test assemblies designed to test concepts for future improved-performance cores for liquid metal reactors and other reactor uses, such as isotope production. This work has primarily remained within the bounds of the original design of the basic cell processing equipment. As new tests have been created for isotope production, irradiated fuel pin reinsertion, space power reactor fuel development, and fuel exposure to record-high burn-ups, the original IEM Cell equipment and support tooling have required innovative modification and remote processing techniques to extend their function into these areas. Special tools and fixtures that allow handling the new assemblies have been developed. For example, a special grapple was designed and built that could be attached to a severed test duct, allowing it to be handled normally.

High burn-up assemblies proved to be more difficult to disassemble due to their distortion. New equipment that could maintain the geometry of a pin bundle of uneven length was required and built. A tool that smoothly pulls a row of fuel pins off of their retaining rails has also proven to be a great success.

VII. REMOTE MAINTENANCE

Remote maintenance performed on plant equipment has included cleaning and changing the CLEM grapple and cleaning and exchanging fuel-handling machine drip pots. These procedures were initially intended to be done in the IEM Cell but were readily done manually because of low radiation levels. As the grapple and drip pots became more radioactive, the maintenance procedures were returned to the IEM Cell to reduce personnel radiation exposure.

The IEM Cell tooling and equipment were designed to be remotely removed from the cell for maintenance and repair at an external facility. However, as contamination levels increased, it became more challenging to transfer equipment out of the cell and decontaminate it sufficiently before maintenance. A first response was to develop a shielded transfer system to remove such equipment. An on-going effort is being made to incorporate remote maintenance and repair capabilities into design modifications. Additionally, failure-mode analysis has led to changes that greatly improve equipment reliability. The present emphasis is to do as much in-cell maintenance as possible. For example, a key fell from a concentric shaft point on a large piece of cell equipment. The retaining set screw was inaccessible. Removing the equipment would put the IEM Cell out of service for several weeks. A new key was welded to a cup with set screw in its side. The key was inserted by MSM and held in place by the cup's set screws.

VIII. CONCLUSION

The IEM Cell has performed well for its first ten years, meeting the challenges and ever-changing requirements placed on it. Its versatility demonstrates the capability to support a challenging future.

REFERENCES

1. P. W. McGuinness, "Large Remote Manipulator Operation and Maintenance Experience at the IEM Cell," *Proceedings of the International Topical Meeting on Remote Systems and Robotics in Hostile Environments*, pp. 437-444, Pasco, Washington. (April 1987).

2. J. J. Kalk, "Fastener Tightening in a Radioactive (Hot) Cell," *Proceedings of the International Topical Meeting on Remote Systems and Robotics in Hostile Environments*, pp. 423-427, Pasco, Washington. (April 1987).

3. F. R. Trowbridge, "Core Component Measuring System at the Fast Flux Test Facility," *Proceedings of the 31st Conference on Remote Systems Technology*, pp. 103-108, San Francisco, California. (November 1983).

4. B. A. Carteret, "Fast Flux Test Facility Interim and Examination and Maintenance Cell Contaminated Sodium Recovery System; Remote Handling Design Consideration," *Proceedings of the ANS Third Topical Meeting on Robotics and Remote Systems*, pp. 5-17-1 - 5-17-7, Charleston, South Carolina. (March 1989).

5. P. W. Gibbons, "Fast Flux Test Facility Interim Examination and Maintenance Cell Fuel Duct Cutters: *Remote Operations Design Considerations*," *Proceedings of the ANS Third Topical Meeting on Robotics and Remote Systems*, pp. 8-13-1 - 8-13-8, Charleston, South Carolina. (March 1989).

6. J. J. Kalk, "Use of Low-Cost, Disposable Components in a Remote, Hostile Environment," *Proceedings of the ANS Third Topical Meeting on Robotics and Remote Systems*, pp. 8-14-1 - 8-14-6, Charleston, South Carolina. (March 1989).

7. D. M. Romrell, "Remote Cutting of Irradiated Fuel Ducts at FFTF," *ANS Proc. 32nd Conference on Remote Systems Technology*, pp. 55 (1984).

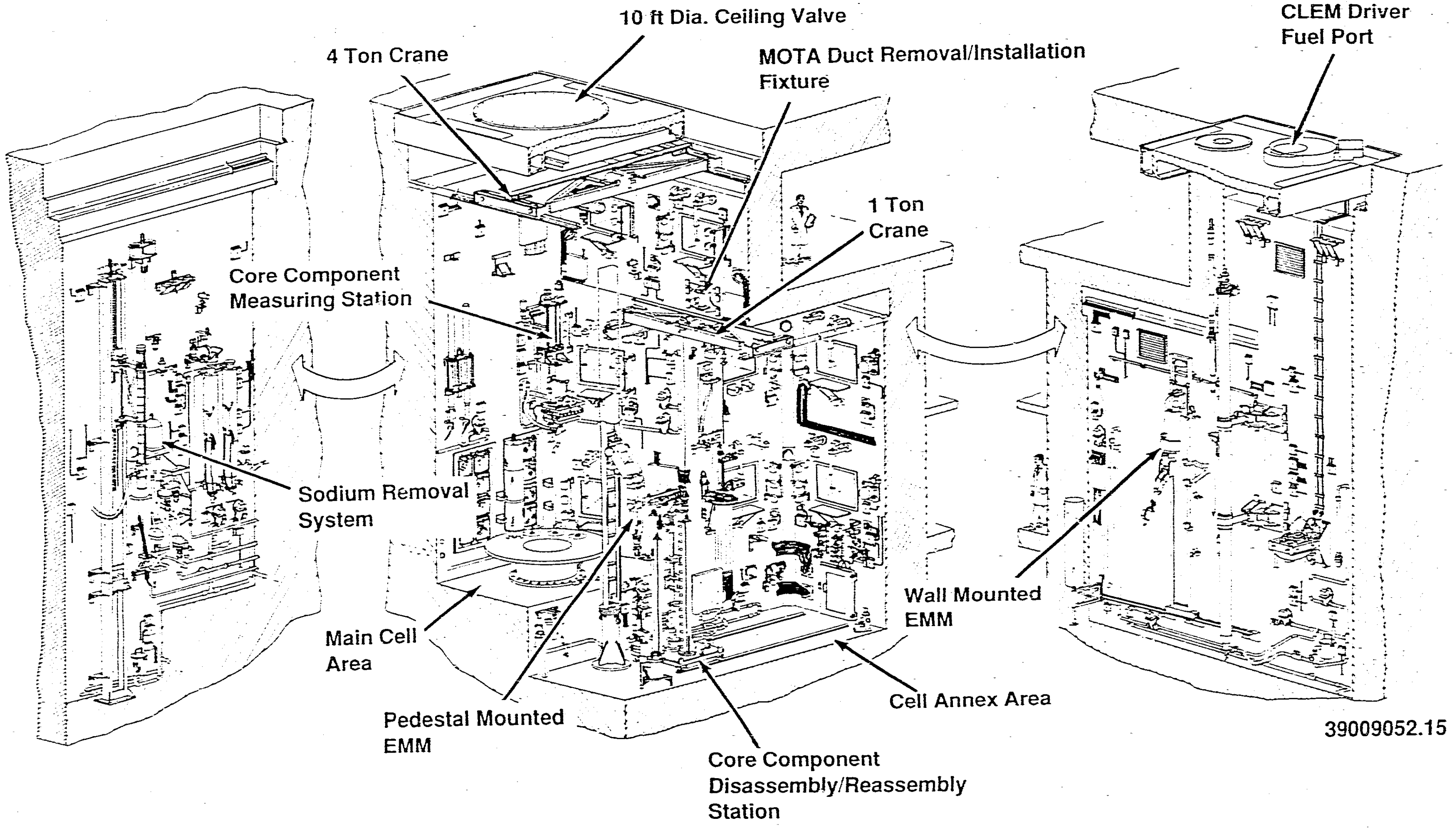
8. P. W. Gibbons, "Fuel Assembly Duct Cutting in the FFTF/IEM Cell," *ANS Proc. 33rd Conference on Remote Systems Technology*, pp. 55 (1985).

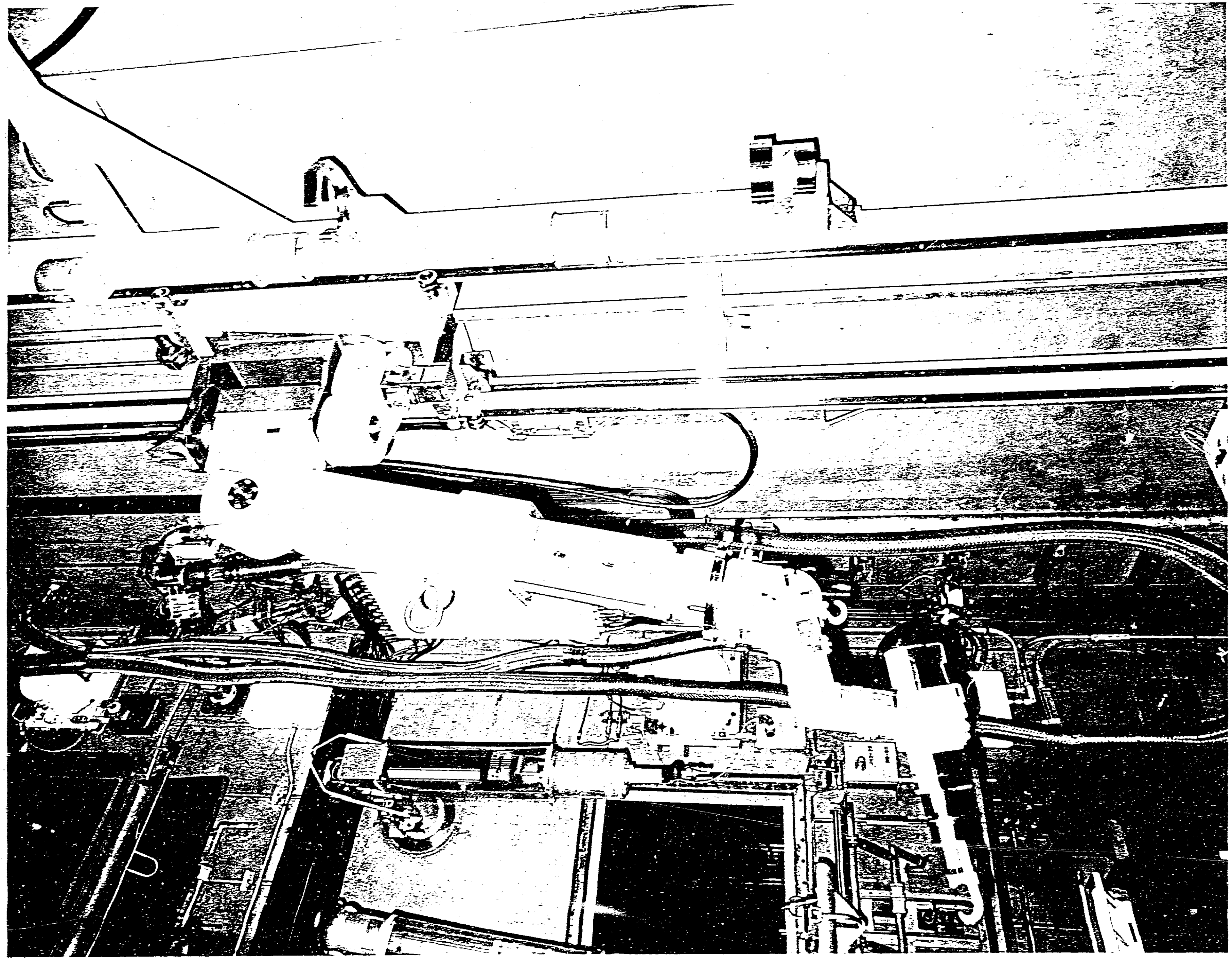
9. W. J. Schuck, L. F. Hill, and W. M. Gajewski, *The Performance of Electrical Equipment in a Dry Argon Atmosphere*, HEDL-SA-2458-5, (June 1981).

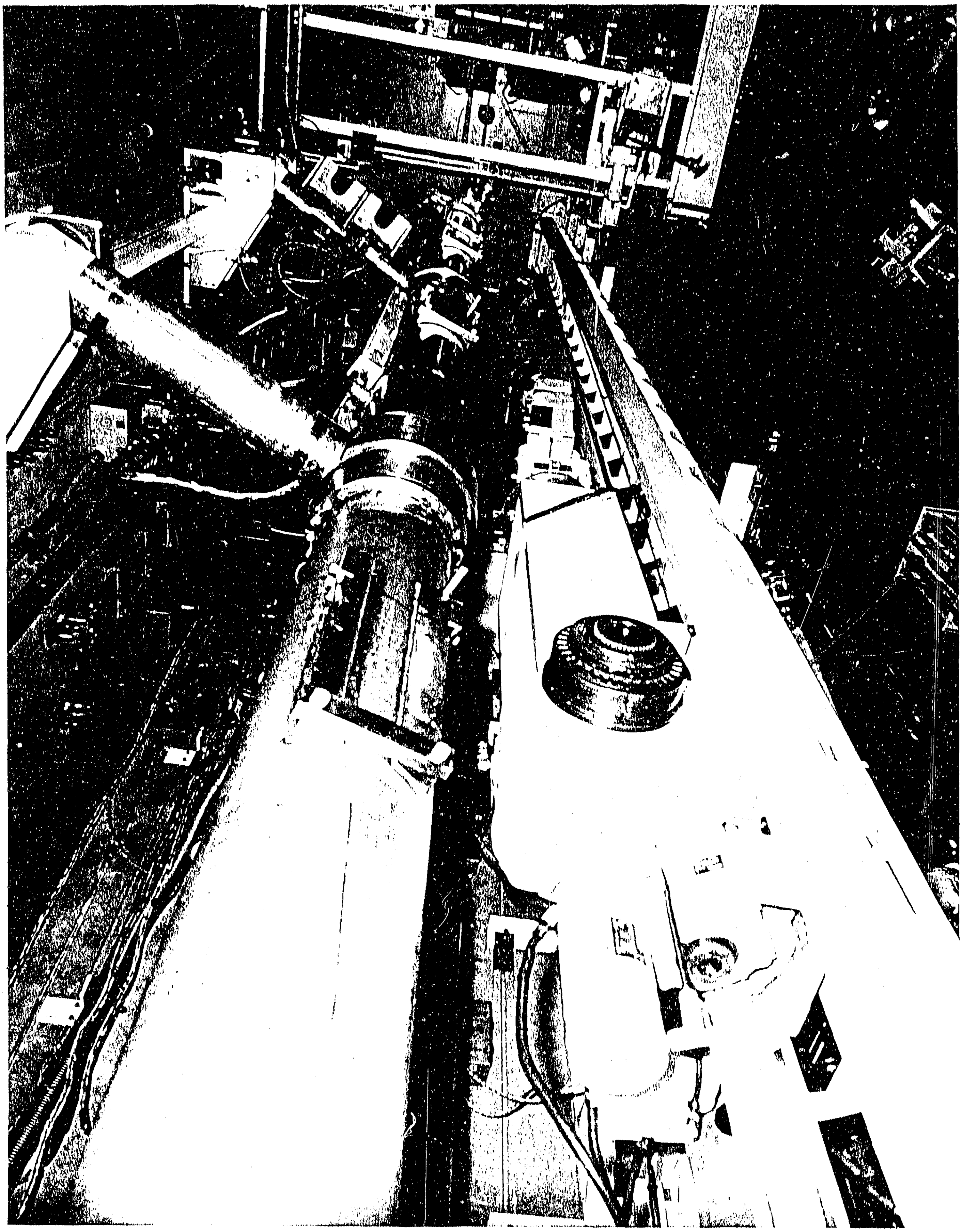
10. P. W. Gibbons, "FFTF/IEM Cell Fuel Pin Weighing System," *Proceedings, 35th Conference on Remote Systems Technology*, pp. 117, (1987).

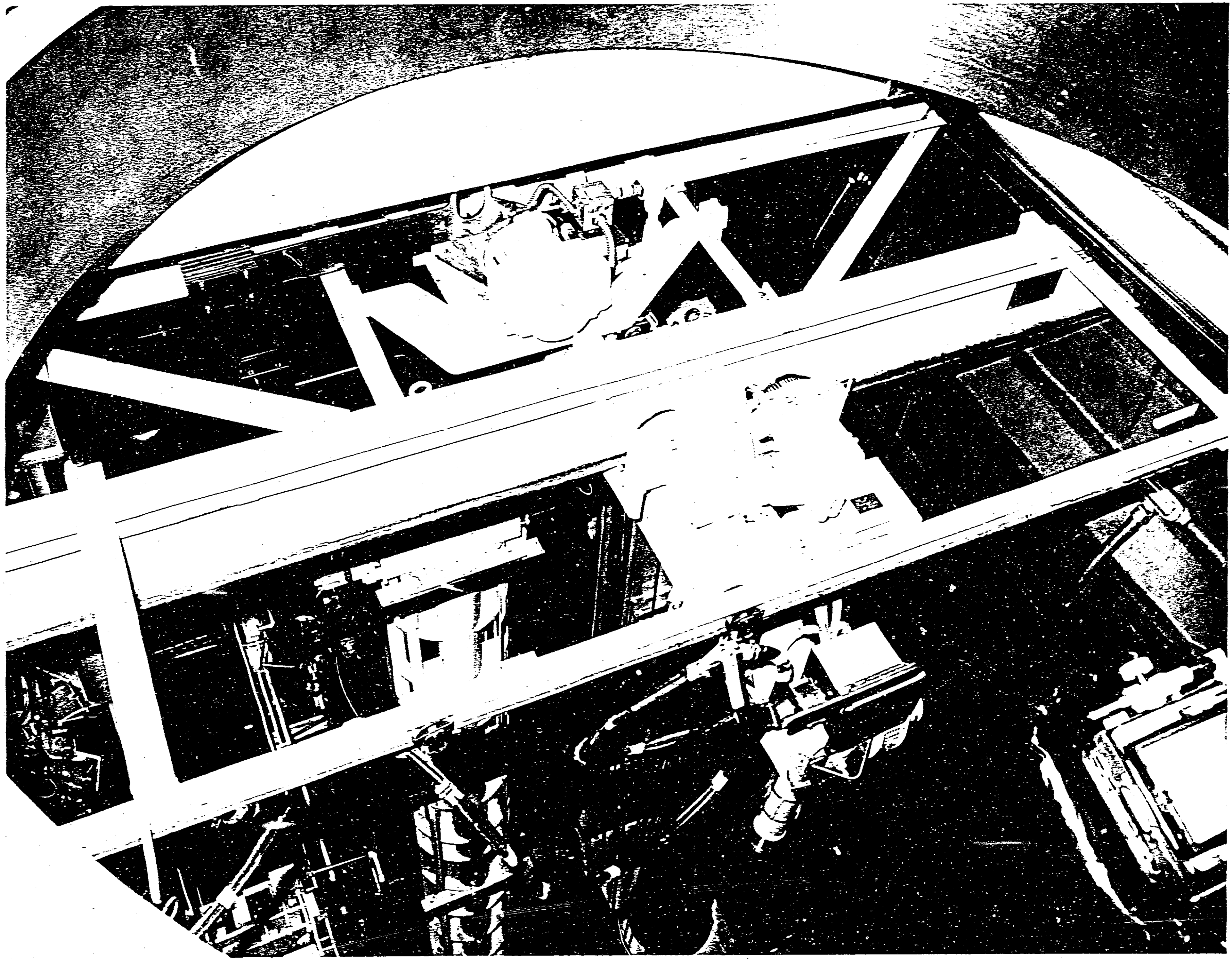
11. P. W. Gibbons, "HT9 Duct Cutting - IEM Cell and Mockup Testing Experience at FFTF," *Proceedings, 35th Conference on Remote Systems Technology*, pp. 98, (1987).

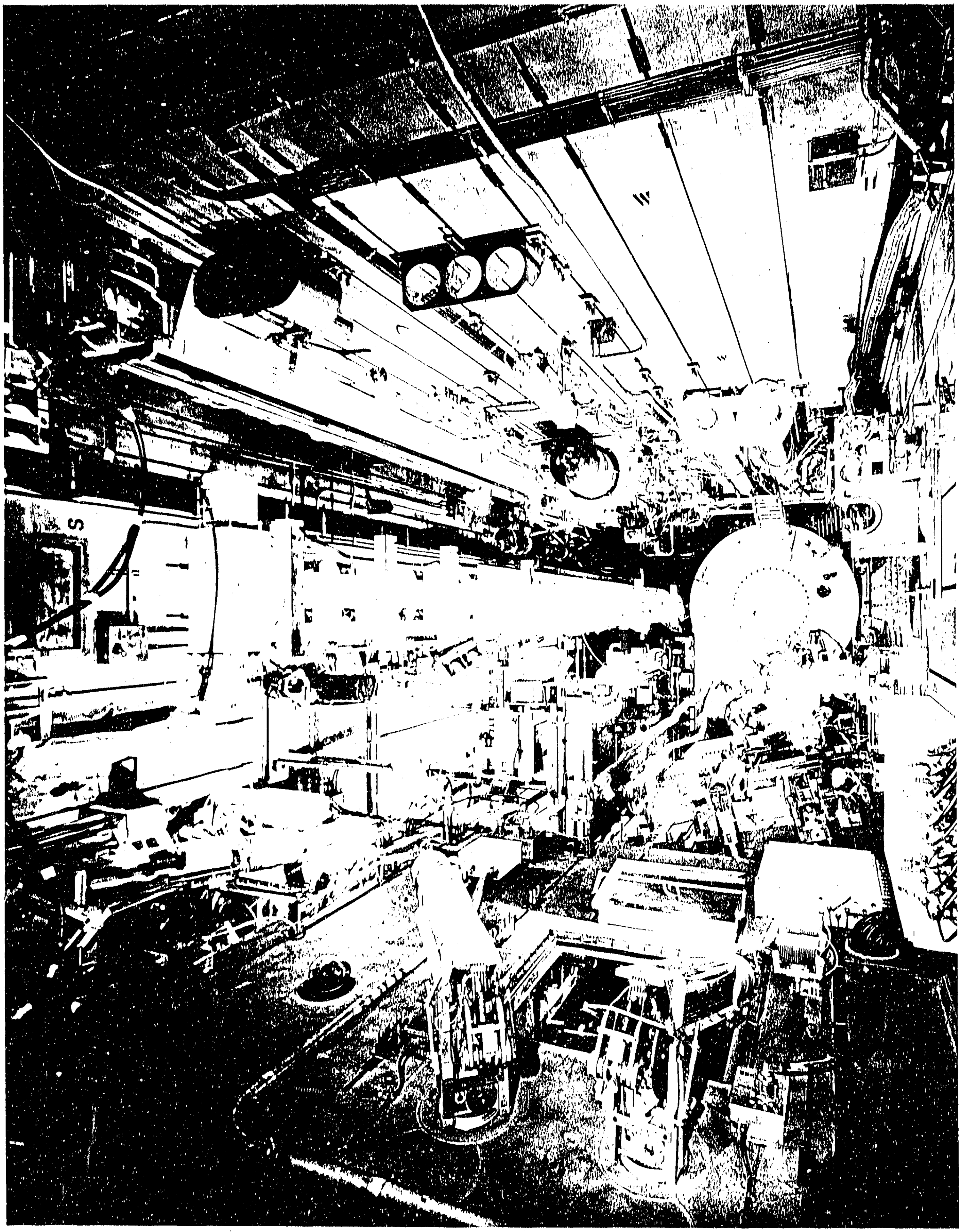
12. Rodney K. Greenwell, "FFTF/IEM Cell Fuel Pin Removal Equipment," *Proceedings, 35th Conference on Remote Systems Technology*, pp. 87, (1987).

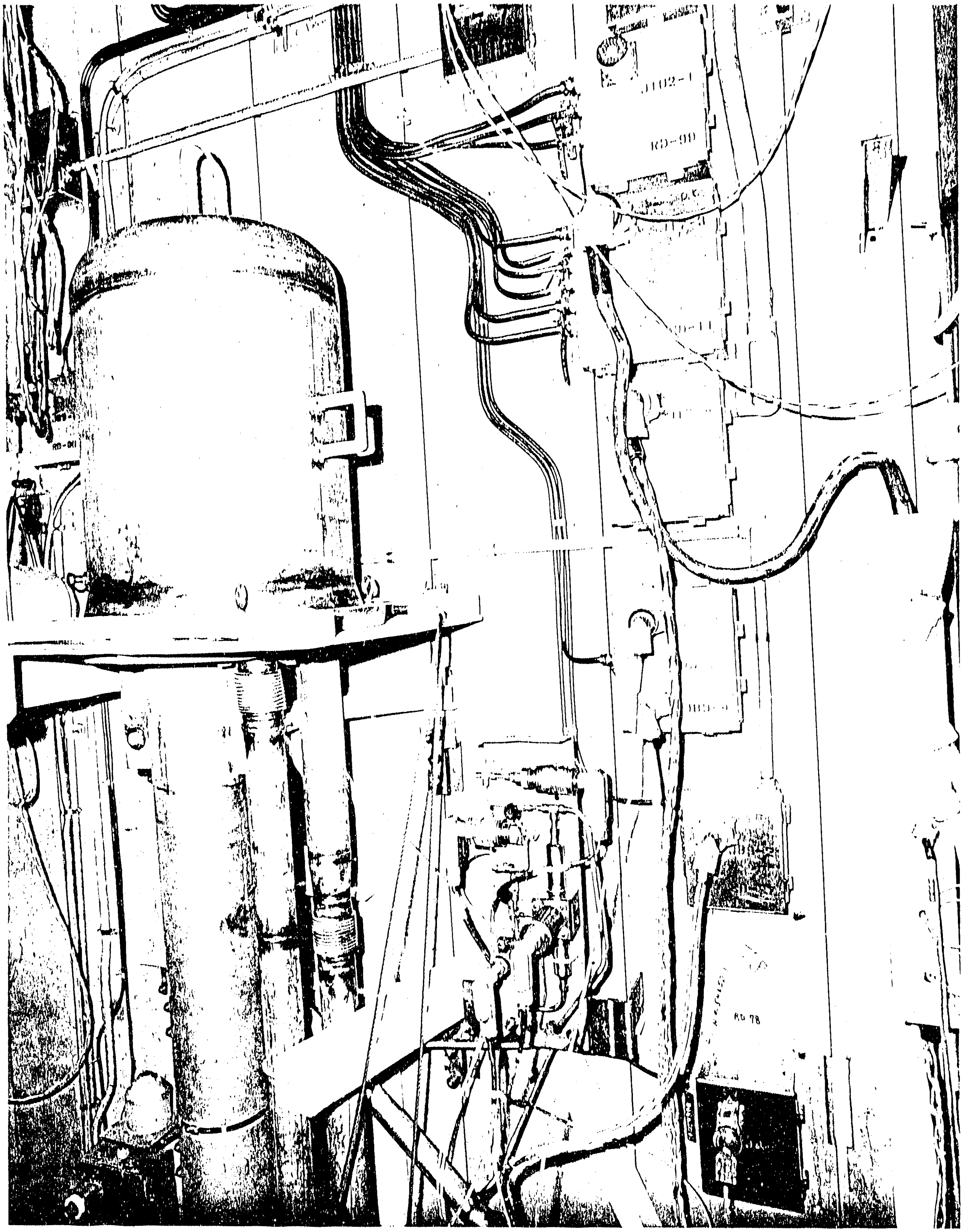

10 ft Dia. Ceiling Valve
CLEM Driver Fuel Port
4 Ton Crane
MOTA Duct Removal/Installation Fixture
1 Ton Crane
Core Component Measuring Station
Sodium Removal System
Wall Mounted EMM
Main Cell Area
Cell Annex Area
Pedestal Mounted EMM
Core Component Disassembly/Reassembly Station
39009052.15

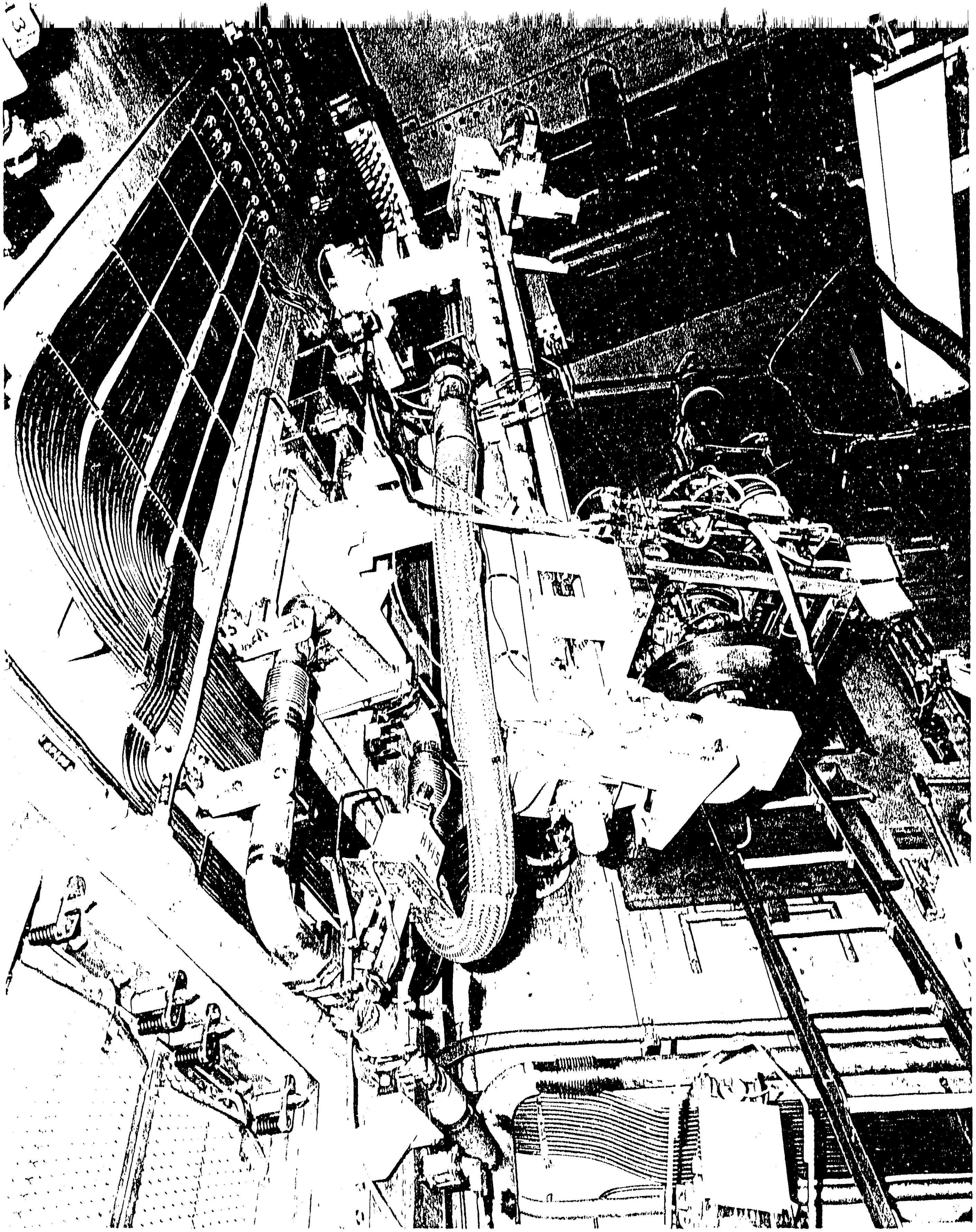


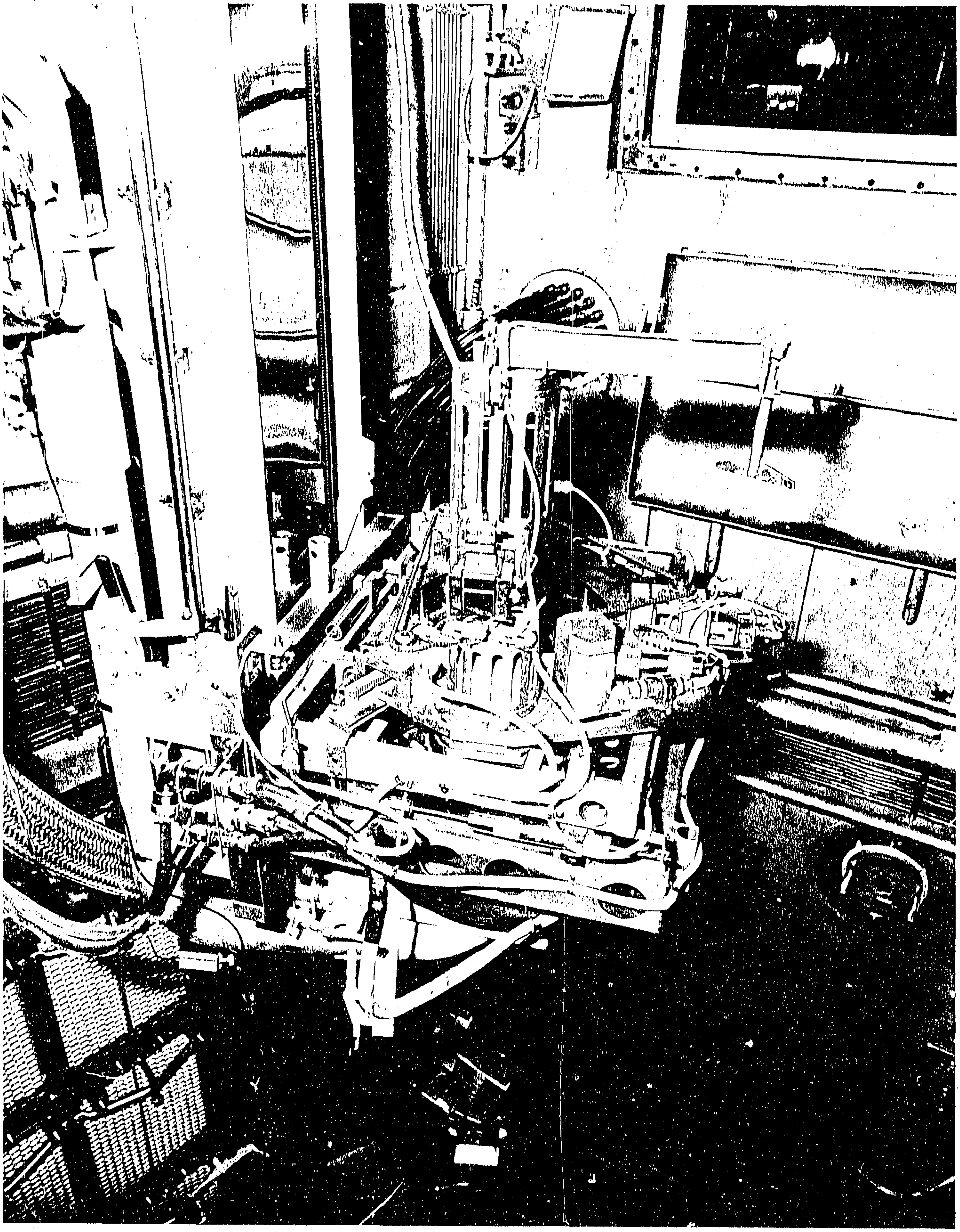


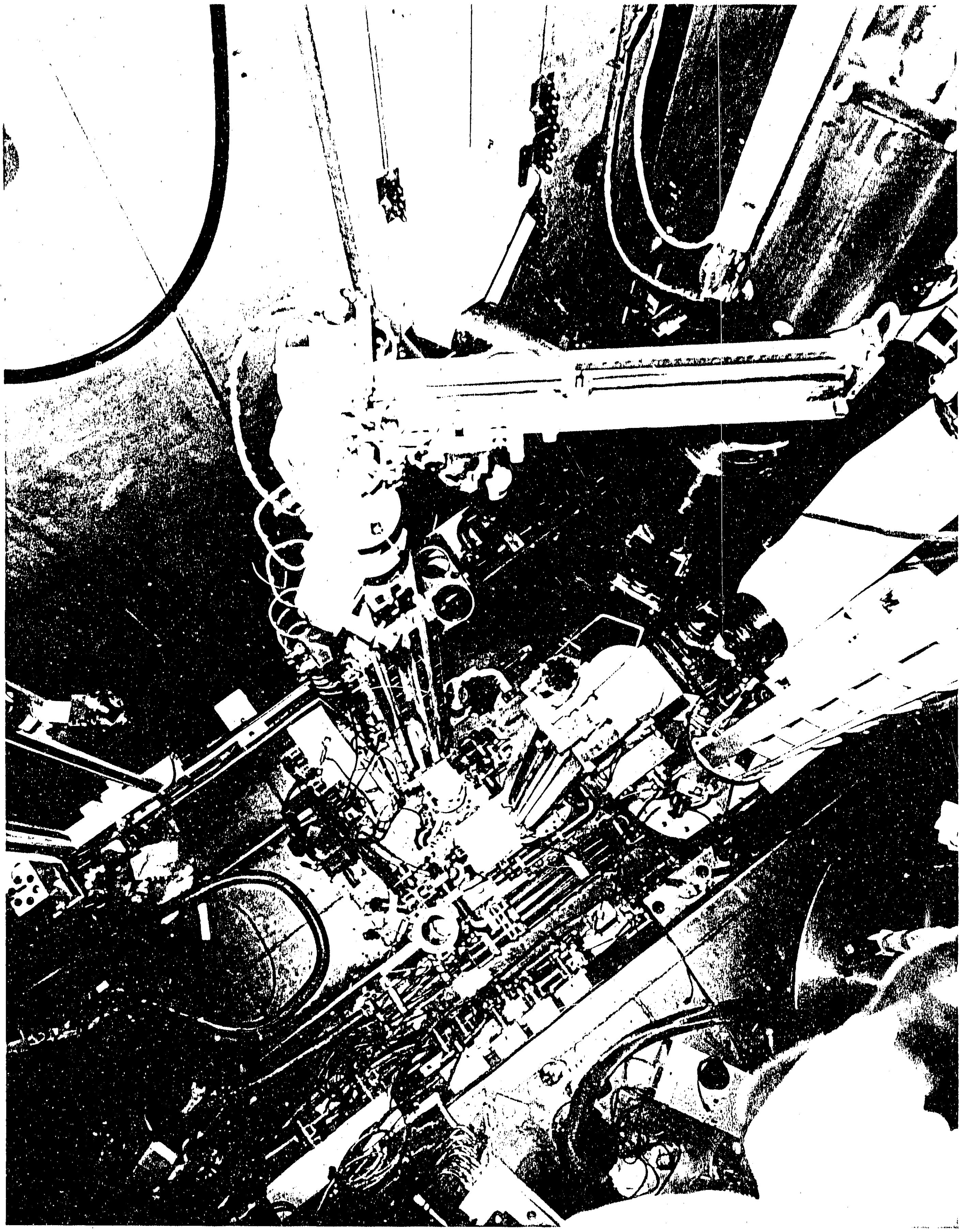



S


J102-1
RD-90
RD-81
RD 78







- END -

DATE FILMED

11 / 06 / 90